MULTIPLE LINK CONNECTOR LIST

Field of the invention

[001] The invention is directed to management of communication networks and in particular to a multiple link connector list for display on the graphical user interface (GUI) of such networks.

Background of the Invention

[002] Modern management systems provide fully integrated network management for various technologies such as LAN, TDM, Frame Relay, ATM and IP, using a rich graphical user interface (GUI). A GUI (graphical user interface) uses object oriented programming techniques to present the information to the network operator for visual inspection, typically using interactive windows. The GUI selects the information to be presented in a window in accordance with a respective request in the context of network management and service provisioning capabilities of the network. The operators monitor and control the display of information on a video terminal (workstation) and the GUI enables the network management system (NMS) to receive, reject, accept and respond to the requested actions.

[003] Each window uses basic displayable elements and controls (widgets), such as icons, pull-down menus, buttons, selection boxes, progress indicators, on-off checkmarks, scroll bars, window frames, window manipulators, etc. Examples of GUI windows are topology maps providing graphical representations of the network, where basic icons are displayed for each network object. Information about the state of the objects on the map is generally conveyed by outlining the icons using solid, colored, dashed, tri-dimensional representations. Equally important, the maps also show the connections between the icons representing the network elements.

[004] Often a GUI map must display connections to network elements (NE's) that are not part of a currently displayed map. For example, the topology maps displayed by Alcatel's network management 5620NM show connectivity outside of the currently displayed map with arrows originating at the respective NE's or NE group on the map, and identify the names of groups that contain NE's with which they are connected, at the tip of the arrows. Often, an NE or a group is the origin over 50 arrows, making the map very cluttered. As the arrows cannot be moved, they often overlap and are not distinctly visible. As a result, the users are not able to 'point and click' a desired connection for selecting it.

[005] The operators need to be provided with a simple way to identify the nodes outside the currently displayed map that are connected to the NE's or groups in their respective map, for easy, user-friendly problem analysis and resolution. Therefore, a way to display this information, without cluttering the respective map is highly desirable.

[006] In addition, in many cases the users wish to access the NE's that are outside the node group shown on the current map. When the user wants to access such outside NE's, s/he must list them or use a 'Find node' command. Therefore, there is also a need to provide a more efficient way to access the nodes outside of the node group shown on the current map.

[007] Connectors on network topology maps such as the map provided by Alcatel network management system 5620 NM are just a label, and clicking on such a connector does not allow users to go to the location displayed on the label. Still other NMS's enable viewing another group map by clicking on a connector, but the group map the connector leads to needs to be manually configured. Often, network connectivity is not point to point but could span many NE's which may be in many different groups. Users would like to check all devices associated with such multi-hop connections. Being able to follow these connections from device to device without regard to which group the various

associated devices are in, and without having to set the group maps for each connector manually, is a very valuable feature.

Summary of the Invention

[008] It is an object of the invention to provide a GUI with the ability to display on a current network topology map a multiple link connector list that identifies all the links connecting the displayed NE's and groups with far endpoints outside of the current map, and their status.

[009] Accordingly, the invention provides a method of displaying all links connecting a network device with network devices outside a map currently presented on a graphical user interface (GUI) of a communication network, comprising: a) collecting data for all objects to be displayed on the map in response to a request transmitted over the GUI; b) bundling all connections between the network device and a group of network devices outside the map into an outside link; c) grouping all outside links for the network device into a multiple link connector (MLC) object and associating the MLC object with an interactive connector icon; and d) displaying the map showing the interactive connector icon attached to the network device.

[0010] The invention is also directed to a modified graphical user interface (GUI) of the type adapted to transmit commands and display information with a view to enable management of a communication network, comprising: means for collecting map data for a network device to be displayed on a map of interest; means for bundling all connections between the network device and a group of outside network devices external to the map into an outside link, and maintaining a connections list L(n) for each outside link; and means for grouping all outside links for the network device into a multiple link connector (MLC) and associating the MLC with an interactive connector icon, wherein the interactive connector icon is displayed on the map attached to the network device.

[0011] According to still another aspect of the invention, a method of using a modified graphycal user interface (GUI) adapted to reduce the cluttering of icons on a map of interest is provided. The method comprises: a) whenever a network device is connected to more than one outside network device of a group of outside network devices external to the map, displaying an outside link connecting the network device with the group using an interactive multiple link connector icon; and b) selecting the multiple link connector icon on the map to obtain a multiple link connector list, displaying an interactive outside link widget associated with an interactive group identification widget for each group of outside network devices connected to the network device.

[0012] In addition, the invention is directed to a comprehensive network map for a GUI of a communication network, illustrating all outside links to groups of network devices external to the map, comprising: a network device icon, illustrating a network device in the context of the map; and an interactive multiple link connector icon associated to the network device, representing all outside links between the network device and all groups of outside network devices connected to the network device.

[0013] Advantageously, the invention enables the users to readily view the entire list of linkages of the NE's and groups displayed on a GUI map and their status. This feature becomes especially important as network nodes become highly interconnected. By automatically creating composite connectors, map clutter is significantly reduced, providing the user with a better view of the network and with the ability to take better and faster corrective actions.

[0014] The multiple link connector list according to the invention also enables a user to view the links going outside of the current map, or the corresponding network element group. This saves an operator time when navigating network maps. Furthermore, automatically creating composite connectors saves an operator the time and effort of manually reducing map clutter.

Brief Description of the drawings

[0015] The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of the preferred embodiments, as illustrated in the appended drawings, where:

Figure 1 illustrates an example of a current GUI map where the connectivity to nodes outside the map is shown with arrows (prior art);

Figure 2 is a block diagram of a multiple link connector-enabled GUI according to the invention; and

Figure 3 is a window showing an example of a multiple link connector list according to the invention.

Detailed Description

[0016] Figure 1 illustrates an example of a GUI map **1** showing two network groups identified as "Hmb1 A-C" and "Hmb1 D-C". Each device on map **1** is heavily connected to a plurality of network devices outside map **1**. These links are shown by arrows.

[0017] Due to the large number of connections to outside NE's, most of the information about the links shown by arrows is useless, in that it cannot be readily read. Thus, while the identification of links such as links **10** and **11** is clear on map **1** ("to Kiel", and "to Flensburg" respectively), the identification of link(s) as these shown at **12** is unclear. This is because there are two or more overlapping arrows, and correspondingly, two or more overlapping link identifications. As the operator cannot move the arrows, s/he cannot distinguish the link identification, and also s/he is not able to 'point and click' a desired connection for selecting one of the overlapping links.

[0018] In addition, the operator cannot access an NE that is outside the node group shown on the current map to further investigate the condition/state of that

connection. When the user wants to access NE's outside the map, s/he must list them, or use a 'Find node' command.

[0019] Figure 2 illustrates a block diagram of a multiple link connector-enabled GUI **50**, also called here a "modified GUI", illustrating specifically the units that enable generation of a window **25** according to the invention. A GUI unit **30** performs conventional user interface functions enabling an operator to monitor and manage the network, as well known. For the example used in this specification, GUI unit **30** provides an operator with a map of interest **25**, which is displayed on the screen of a workstation **100**. Also, GUI unit **30** enables the operator to perform various operations by using the widgets provided in the respective window by performing typical "point-and click" operations.

[0020] A simple map **25** has been provided for clarity; normally a map shows multiple network devices and their interconnection at the respective hierarchical level. Thus, there could be maps represeting a part of a network at the network node level, or at the shelf, slots, cards, ports, etc. levels. Each node could be in a group that could be inside another group, inside another group, etc. The term "network device" or "network element" is intended to generically designate any physical or logical entity of the network (managed object). The term "group' refers to a logical grouping of network devices.

[0021] Map **25** shows in this example three network device icons **ND1**, **ND2** and **ND3**, link icons **2** and **3** between the devices within the map, and a link icon **10** illustrating a single connection from **ND2** to an outside node **ND4** (not shown). The network devices are routers here, but they could be any other objects at the hierarchical level of the respective map.

[0022] Map **25** also shows a multiple link connector **5**, which indicates to the operator that **ND1** is connected directly to more than one network device outside map **25**. To summarize, a multiple link connector **5** represents according to the

invention all outside links established between a network device on the current map and all node group outside the map. The term "outside link" designates all connections between a network device on the current map to a group of network devices outside the map. As such, an outside link to a specified outside group may include a plurality of connections between the network device on the map and the respective outside network devices of the group. The term "outside network device" or "outside group" is used to designate generically any network element, (router, switch, shelf, card, etc) or group of NE's , which is outside the map currently shown by the GUI, but directly connected (linked) with a network device on that current map.

[0023] By using this new representation of the outside links, all links that connect outside network devices to the first network device **Hmb1 A-C** shown on map **1** of Figure 1 could be shown according to the invention using one connector **5**, thereby reducing cluttering of map **1**.

[0024] The connector object **5** is illustrated using a line **15** originating at the respective network device (here **ND1**) and ending with a button **20**. By selecting button **20**, a pop-up window **21** (described later in connection with Figure 3) provides the operator with information on the outside links and devices that are linked to the network devices on the current map. Of course, other icons may be used to designate these objects; what is relevant here is the functionality that this new object (a multiple link connector) enables.

[0025] As shown on Figure 2, GUI unit **30** uses a map data collector unit **40** for accessing an object library **35** with a view to selecting data pertinent to a certain object to be displayed on the map. In this way, GUI unit **30** constructs maps and various dialog boxes necessary for enabling the operator to transmit commands and receive information about operation and status of the network.

[0026] In general, all nodes maintain an object library that comprises data pertinent to the network elements at the respective node, available for use by various network management applications, including the GUI. The information about the ports used by a specified connection is also available at the node; if this information is not readily available, it may be imported from the routing database. It is to be mentioned that the location of the device specifications or the way this information is stored at the node is not relevant to the invention; relevant is the availability of this information.

[0027] Modified GUI **50** also comprises an outside link locator **42** for determining which links on the current map connect a certain network device within the map with outside groups. This determination is performed on the information collected by the GUI unit **30** for the current map. Outside link locator **42** also prepares a connections list *L(n)* including all *n* outside connection directly connecting a network device with network devices of a specified group of network devices outside the map. The individual connections are associated in the list with the respective outside network device. These lists, denoted with **32** on Figure 2, are prepared for each outside device linked with a network device resident on the map. If a network device has only one outside link, such as **ND2** in the example of Figure 2, the modified GUI **50** illustrates these single links as before, with arrows **10** (or similar means), also providing the outside network device identification at the tip of the arrow.

[0028] Based on the connection grouping information assembled by locator **42**, a multiple link connector (MLC) generator unit **44** creates the multiple link connector (MLC) object by grouping all outside links for the respective network device shown on the map, and associating an interactive MLC icon **5** to the connector. Icon **5** is also associated with all appropriate lists **32** pertinent to the respective network device.

[0029] Based on the outside link grouping information assembled by MLC generator **44**, a list organizing unit **46** generates a multiple link connector list (MLCL) which is displayed in window **21** (please note that MLCL and the pop-up window associated to button **20** are both referred by numeral **21**). List organizer **46** enables the operator to select an object of interest on list **21**, by 'a point-and click" operation performed on button **20** to open list **21**, and then to select the objects of list **21** for obtaining further details on linkage information, as described later in connection with Figure 3.

[0030] For example, let's assume that **ND1** is directly connected to seven node groups (as e.g. shown in the example of Figure 3), by seven respective outside links. Let's also assume that only five outside links have multiple connections to the respective outside device. In this case, multiple link connector icon **5** is associated to the network device **ND1**, and with five lists *L(n)*, each maintaining the connections between ND1 and the respective outside device. The pop-up menu **21** lists all seven outside links in connector **5** and the corresponding network devices outside of the map.

[0031] Arrows **a-i** show the sequence of operations for obtaining window **25**. As shown by arrow **a**, the operator requests a map **25**, specifying on the workstation **100** the parameters for this map, as well know. GUI **30** instructs the map data collector **40** to collect the information necessary to show the map, arrow **b**. Unit **40** consults object library **35** to collect the data pertinent to the requested map, as shown by arrow **c**. As the network objects of the map are acquired, arrow **c'**, they are returned to the GUI, arrow **b'**, for display on terminal **100**. At the same time, outside link locator **42** determines which outside connections should be included in list **21**, as shown by arrow **d**. As the outside connections to each outside group and the identification of the respective groups are uncovered, they are placed in a respective list **32**, as shown by arrow **e**.

[0032] As shown by arrows **f** and **g**, connector generator **44** prepares the respective connector object **5** by grouping all outside links for the respective network device (here **ND1**), and provides same to GUI **30** for display on window **25**. List organizer **46** in turn prepares the multiple link connector list **21** providing the association between the outside links from a certain network device resident on the current map and the groups to which these links are directed, arrow **j**. Once the map **25** with all objects requested, including connector objects **5** is displayed, the operator may open pop-up window **21** for a network device of interest, arrow **i**, by selecting button **20**. The operator may further select an outside link or an outside node group on list **21**; these operations are shown by arrow **j**.

[0033] Figure 3 illustrates a preferred look of a window **26**, also illustrating a multiple link connector list **21** according to the invention. In this example, list **21** is again associated with network device **ND1**. Multiple Link connector icon **5** indicates that **ND1** is directly connected to a plurality of outside network devices, and the identification of the outside links and devices can be viewed by selecting button **20**. In this example the right column of list **21** shows all the outside links **10**, **11**, **12**, **13**, etc. and in the left column, shows the corresponding groups of network devices **6**, **7**, **8**, **9**.

[0034] Clicking on an outside link of the pop-up menu **21** opens up a link list **32** with all connections (links) bundled in that outside link. For example, clicking on icon **13** will provide the appropriate list **32** of all connections between network device **ND1** and the network devices **9** in node group3.6, listed on the same row with connector **13**.

[0035] Clicking on an outside node group in list **21**, opens up a map **34** with the network devices in the corresponding node group. For example, clicking on icon **8** will provide the map **34** for group 6.3.